Ammonia Removal Using Ozone

Description

This alternative uses ozone to oxidize ammonia to nitrate in order to meet the discharge ammonia limits. This is an uncommon application of ozone. None of the ozone generator manufacturers that were contacted were aware of ozone being used to remove ammonia from WWTP effluent. There are a few industrial treatment applications, but no applications involving effluent from a biological process.

There are large unknowns regarding this application, all of which will need to be resolved during pilot testing before proceeding to design.

- Dose ratio for ozone:ammonia – The effluent ammonia concentration is much higher than the few industrial applications currently running, so the dose rate is uncertain. Manufacturers have suggested a ratio anywhere from 10:1 to 15:1 based on the textbook chemical reaction for ozone and ammonia.

- Oxidation demand from other pollutants – Since the effluent is treated domestic and industrial wastewater from a biological process, organic compounds (total organic carbon) and dissolved solids (iron, manganese, etc.) will be present that will exert a demand for oxidation. This will require additional ozone. The amount of additional ozone cannot be estimated without pilot scale testing.

- Production of byproducts – Adding ozone to the effluent will produce undesired chemical compounds, such as bromate and NDMA. Additional treatment may be necessary to remove the byproducts from the discharge.

- Reaction time – The time required for complete oxidation of the ammonia level present in the effluent may be significant, i.e. on the order of several hours. This would require a large volume tank for reaction.

- Reaction tank design – In addition to the size of the tank required for reaction, the design of the tank will be complicated. It may be required to be tightly sealed in order to keep the ozone in contact with the effluent for the long reaction time. A batch process may even be potentially required. Excess ozone collection and destruction systems will be required.

Scope and Conceptual Layout

The scope of this alternative is as discussed below.

- Expand Filtration: Additional filtration will help in reducing the overall dose of ozone by removing suspended organic matter. The existing disc filter system could be expanded to reduce the ozone dosing and capital cost identified in the attached EOPC.

- Reaction Tank: While the exact arrangement of the reaction tank is not known at this time, a hydraulic retention time of 6 hours at a flow of 1.0 MGD has been assumed for the purposes of this evaluation. This results in a 250,000 GAL tank with dimensions of 35 FT wide x 70 FT long x 15 FT deep, with concrete construction.

- Ozone Generators: Determining the required dose is difficult for this application since ozone has not been used specifically to oxidize ammonia in WWTP effluent. Additional demand will also result from organics and dissolved solids in the effluent. For the purpose of this evaluation, the demand is estimated to in the 12.5:1 range to achieve oxidation of ammonia to nitrate. Note that further oxidation of nitrate would require additional ozone dose. For a daily flow of 1.0 MGD and an ammonia concentration of 20 mg/L, ozone usage would be approximately 2,000 LB/DAY. Ozone generation systems of this size may require a pure oxygen supply, which can be supplied in bulk or generated onsite.

- pH Adjustment Chemical Feed: The pH of the feed water will need to be increased to around 8.5. A sodium hydroxide storage/feed system is proposed.

- GAC: Granular activated carbon will be used to remove any residual ozone present in the effluent and potential byproducts formed during ozonation. GAC may be required by regulatory review pending results of pilot testing and therefore has not been included in the attached EOPC.

Capital Cost

There are too many unknowns at this point to provide an expected capital cost, but our initial rough estimate is that this alternative will cost between $5M to $10M. Any additional requirements that arise during pilot testing may further increase this rough estimate.

Annual Operating Cost

As with the capital costs, it is difficult to place a value on annual operating costs at this time. Our initial rough estimate for O&M costs (including chemicals, power, manpower, etc.) for the ozone process is between $300,000 to $600,000 per year. Again, any additional requirements that arise during pilot testing may further increase this rough estimate.

Installation of a Pilot Plant

Process testing and demonstration should be accomplished in two phases.

- Pilot scale testing: Based on the results of the bench scale testing, a pilot scale test system can be set up and operated. The pilot scale system would process about 10-20 GPM, and would involve rental of an ozone generator system, construction of representative process tanks and feed systems, operation of the pilot system, monitoring of power and chemical usage, and testing of the inlet and outlet flow of the pilot system. We expect that a one month large scale pilot test costs would will range from $40,000 to $60,000 depending upon the amount of testing and day to day operations tasks that the City performs. However, a small scale 30-day pilot test could be completed for around $10,000 to determine viability of this technology. Larger scale testing may be needed to optimize sizing and design components.

ENGINEER'S OPINION OF PROBABLE COST

FORSGREN Associates Inc.

CITY OF DRIGGS

Proposed Wastewater System Improvements

Project No. 01-19-0019

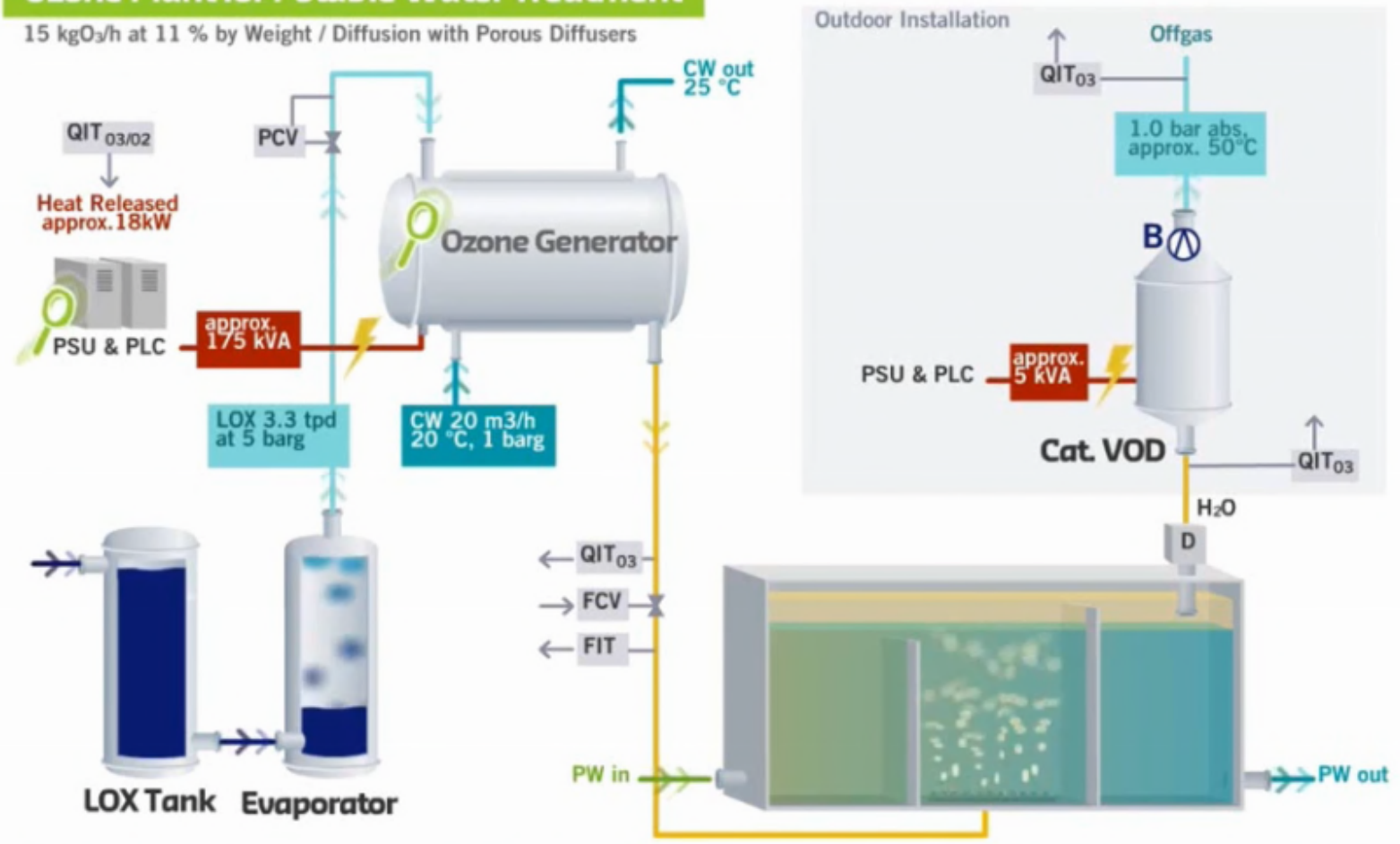
Project: Driggs WW FPS — Date: September 16, 2019

Client: City of Driggs — Prepared by: CM/DN

Line No.	UNIT PROCESS / ITEM DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	Total Price
CONSTRUCTION COSTS - Lift Station					
1	Ozonia System	1	LS	$ 3,000,000	$ 3,000,000
2	LOX Feed System	1	LS	$ 1,250,000	$ 1,250,000
3	Concrete Reaction Tank	169	CY	$ 1,000	$ 168,519
4	Sodium Hydroxide Storage/Feed System	1	LS	$ 50,000	$ 50,000
5	Ammonia Sensors, Plant Controls	1	LS	$ 20,000	$ 20,000
6	Installation of System	1	LS	$ 1,800,000	$ 1,800,000
					$ -
					$ -
TOTAL CONSTRUCTION COSTS					
	SUBTOTAL CONSTRUCTION COST				**$ 6,288,600**
	Contingency Fund (95% Confidence Factor)			20%	$ 1,257,800
	TOTAL CONSTRUCTION COST				**$ 7,546,400**
ENGINEERING, CONSTRUCTION OBSERVATION & FINANCIAL MANAGEMENT					
1	Basic Design Services				$ 754,640
2	Construction Services				$ 377,320
3	Additional Services Prelim Eng Report				$ 5,000
4	Pilot Testing				$ 10,000
5	Bond/Interim Interest				$ -
	SUBTOTAL OTHER PROJECT COSTS				**$ 1,146,960**
TOTAL ENGINEER'S OPINION OF PROBABLE PROJECT COST					**$ 8,694,000**

Ozone Plant for Potable Water Treatment

15 kgO_3/h at 11 % by Weight / Diffusion with Porous Diffusers



C = Compressor
B = Blower Process & Ambient
D = Demister

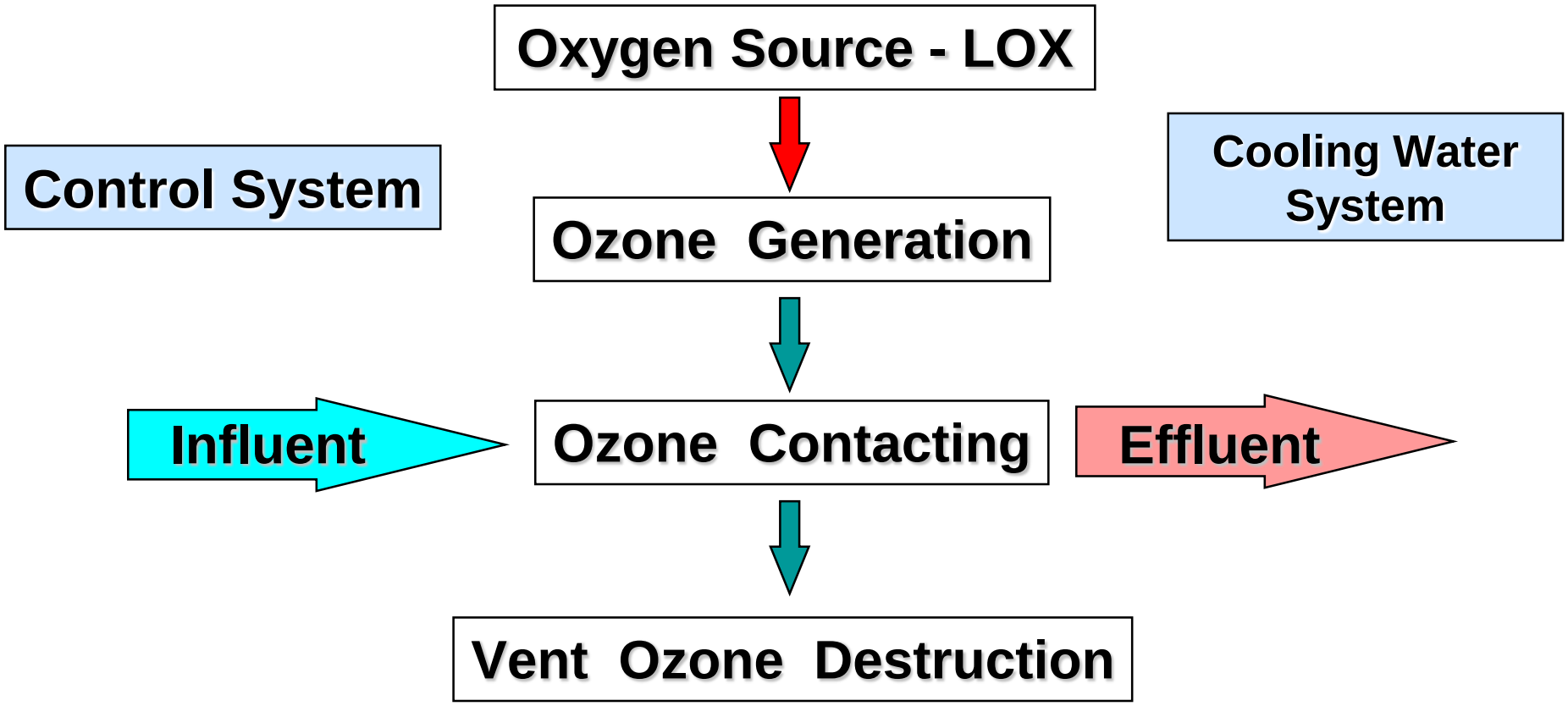
LOX = Liquid Oxygen
PLC = Programmable Logic Controller
Cat.VOD = Catalytic Vent Ozone Destructor

PW = Potable Water
PSU = Power Supply Unit
CW = Cooling Water

QIT = Ozone & Oxygen Monitor
FCV = Automatic Flow Control Valve
FIT = Flow Indicator Transmitter
PCV = Pressure Control Valve

Ozone Simple PFD

OZONE SYSTEM BLOCK DIAGRAM



Ozone Process Flow Diagram